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OPTICAL DEFECTS IN SCHOOL CHILDREN.

AN ADDRESS

BEFORE THE

MASSACHUSETTS

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AT ITS

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ANNUAL MEETING, OCTOBER 17, 1868.

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AN ADDRESS BEFORE THE MASSACHUSETTS TEACHERS' ASSOCIATION
AT ITS ANNUAL MEETING, OCTOBER 17th, 1868.

By Henry W. Williams, A. M., M. D., of Boston, Fellow of the American Academy of Arts and Sciences; Lecturer on Ophthalmic Surgery in Harvard University; President of the American Ophthalmological Society.

In responding, as a matter of public duty, to the invitation of your President, I shall have the honor of speaking of some topics relating to education as considered from a physician's point of view; and shall endeavor to explain, as briefly and simply as may be, certain optical conditions and their consequences, not as yet very well understood by the community, but which have an important bearing upon our future well-being as an educated people.

The best methods of imparting knowledge, and of rendering it available, as far as possible, for the necessities of the probable future of the learners, it is not my province to discuss. But, expressing no opinion as to what healthy children, with healthy eyes, may profitably be taught, I wish to show that numerous cases present themselves which require a deviation from established standards, both as to the mode and the amount of study, — on penalty of sacrificing the future usefulness of the scholar, and making him incapable of profiting by the knowledge he has injured his eyes to obtain.

I would show, also, that the threatened misfortunes must be averted through the intelligence and vigilance of teachers; since, in many instances, the pupil himself will make no complaint, but will even be unconscious of the dangers he is incurring till the mischief is beyond repair.

Within a very few years, great advances have been made in a knowledge of the optical conditions necessary to perfect vision, and of the causes which disturb the normal exercise of this function. Till recently, much uncertainty existed as to whether the imperfect sight, or inability to use the eyes, frequently complained of, depended on optical defects or on organic structural changes. But the invention of the ophthalmoscope, by means of which we are able to illuminate and explore the interior of the eye, has made it possible at once to detect the latter, besides aiding in determining the presence of the former. It shows, moreover, in certain cases, the co-existence of both these morbid conditions, and their mutual dependence.

Not to trespass upon your patience, I leave out of question, in these remarks, such defects of sight as are due only to structural changes, — though many of these so far lessen the visual power as to allow of only moderate and cautious use of the eyes, — and shall ask your attention to some of the more common disturbances of the refractive and accommodative powers of the eye.

The normal eye, when looking at distant objects, (such as are at or beyond eighteen or twenty feet from it, the rays from which are considered as virtually parallel,) may be regarded as in a state of rest, and as an organ of *refraction* merely. Such parallel rays are without effort brought to a focus upon the retina, which forms a distinct image of the object looked at, and conveys the impression to the brain through the medium of the optic nerve. In order to the full perception of this mental impression, both eyes must receive an image upon corresponding portions of their retinæ, — any want of harmony in the direction of the axes of the two eyes, or any loss of perceptive power in either, at once rendering vision in a measure defective or confused.

The refractive power is modified by three principal deviations from the normal type in the construction of the organ. Sometimes the antero-posterior axis of the eye is too short, the globe is flattened from before backwards, rendering its refractive power insufficient to bring even parallel rays to a focus upon the retina. This is termed hyperopia or hypermetropia, or oversight, the focus being formed at a point beyond the proper limit. In other cases, the axis is too long, giving to the globe the form of an acorn or an egg, and by its excess of refraction bringing parallel rays to a focus before they reach the retina. For the formation of a distinct image in these eyes, rays must be divergent as they enter the globe. This is myopia or short-sightedness. In a third condition, the refractive surface of the cornea has a different curvature in different meridians, so that rays entering the eye in one plane come to a focus sooner than those entering in a plane at right angles to the first. In these cases, vertical or horizontal lines may be clearly seen, while those at right angles to them will appear indistinct, giving rise to much confusion of sight. This is astigmatism.

But in addition to this passive refraction, taking place when the organ is in a state of rest, the eye is endowed with another important optical function. It has a capability of *accommodation*, by which its focal power can be increased, and adapted, in a normal eye, to bring to a focus on the retina divergent rays, such as emanate from near objects. Thus only do we become able to read.

This enhanced refraction is effected principally by the action of the ciliary muscle upon the crystalline lens, increasing its convexity and thus its concentrating power. It is the loss of this power of adaptation, from the gradually increasing hardness of the crystalline precluding this change of form, which makes it necessary for most persons to assume convex glasses for looking at small objects, after reaching a certain age; though they still see clearly at a distance, which they could not do if flattening of the entire globe occurred with advancing age, as was formerly supposed to be the case.

Simultaneously with the action of the ciliary muscle upon the lens during accommodation for near vision, an auxiliary movement takes place in the muscles which turn the eyeballs towards the nose; this harmonious associated action being essential to perfect binocular vision for near objects.

Anomalies either of refraction or accommodation may seriously interfere with vision, and render the eyes incapable of close and continuous application.

In hyperopia, where the focus for parallel rays is behind the retina, an accommodative effort must be made to bring even these rays to a focus upon its surface. If the degree of hyperopia is moderate, and the accommodative power good, divergent rays from near objects may still be brought to form a distinct retinal image. But the adaptive capabilities of the crystalline lens, and therefore of the eye, begin to diminish even at an early age, and if the hyperopia is considerable, the accommodative effort requisite for reading ordinary print cannot be kept up for more than a brief period. If it be longer persisted in, the hyperopic child or youth begins to have a sensation of discomfort and fatigue over the brows as well as in the eyes, which at last is so severe as to force him to desist; or, perhaps, the overstrained accommodative muscles give way, and vision at once becomes indistinct. After a few minutes' rest, this delicate muscular power is so far restored that study is again possible for a certain period, when the same phenomena recur just as we see any other overtasked muscles yielding to fatigue.

This state of things is often little appreciated. The boy's eyes look well, and he has perfect vision. He makes no complaint while at play, and sees even fine print clearly when he first looks at it, and until his accommodative power becomes exhausted. Indeed, he cannot himself understand how it is that he is unable to learn his lessons, and why, perhaps, if called upon to read aloud he makes seemingly wilful blunders. Naturally enough, his teachers and parents think him idle or careless. But, with him, inattention is an imperative necessity, forced upon him by the pain resulting from continuous effort. As the day wears on, his difficulties increase with every hour of study, especially if during the short winter afternoon the light becomes insufficient. The more diligently he endeavors to apply himself to his books, the less able he is to do so, and the greater is the confusion of his vision; and he is perhaps reproached, if not punished, for his negligence, before his friends become, at last, aware of his infirmity, and give him tardy credit for good intentions.

Such pupils need to be allowed to rest their eyes frequently, and should not be required to keep them fixed upon their books. They should have seats in the school-room so placed that they may have ample light, and should do little evening study. It should be understood that the state of their eyes is practically similar to that so familiar to us in old people, who can do nothing without their glasses, and they should not be expected or allowed to continue difficult work, as, for instance, in using a lexicon, too long at a time. Great leniency should be shown towards shortcomings in the details of many studies. Even ignorance as to the precise situation of the capital of Kamtschatka might be overlooked as a venial offence, rather than harm should befall the scholar's eyes from straining them over the map to find that important place; especially as we may feel well assured that the pupil will have little difficulty in learning all he wants to know about it whenever he visits that country.

It is needless to say that too many of our school-books, printed with worn type, upon thin paper, unfit as they are for even normal eyes, are especially to be deprecated in the cases just described. The makers of these abominations, and the school committees who from motives of false economy encourage their use, have much to answer for.

Where the hyperopia is excessive, the precautions I have urged will not be sufficient; but the pupil requires the aid of convex glasses for reading, and sometimes for distant vision; this being now and then the case even at seven or ten years of age.

A condition analogous to this often follows some of the diseases of children, particularly diphtheria, measles or scarlatina, resulting from a partial or complete paralysis of the nervous branches supplying the accommodative muscles. Usually this is but a temporary affection; but while it continues, it gives rise to symptoms resembling those of which an account has been given. The child appears tolerably strong and well, but his nervous system is still unequal to the fulfilment of some of its more delicate functions. The same caution is here to be observed as to protracted use of the eyes; but more may be accomplished by medical treatment, and there is less often occasion to resort to glasses; though in some instances they may be used for a time with marked advantage.

A consequence of hyperopia, which would scarcely have been expected, is strabismus or squinting, the eyes turning towards the nose (becoming crossed, as it is termed), because of the excessive efforts of the internal recti muscles to augment the accommodative power by convergence of the optic axes. This deviation ordinarily begins about the time when the child first tries to see small objects distinctly; and if allowed to increase, not merely becomes a confirmed deformity, but, which is of far more importance, leads to a gradual loss of vision in the eye which deviates most. This diminished power results from the non-formation of images on corresponding parts of the two retinæ; and distinct binocular vision being therefore impossible, the squinting eye at length ceases to make any effort to see, and disregards the relatively faint image formed on its retina, until the visual faculty dies out for want of exercise, and the eye, to avoid confusing its fellow, turns yet more inwards. If sight is separately tested in the two eyes, it is frequently found to be very imperfect in that which shows most obliquity.

To obviate these evils, it is essential that eyes which show a tendency to strabismus should not look too closely or too long at small objects; or that they should be aided by convex glasses, which, though in young subjects they have their inconveniences, are yet frequently indispensable. An operation for rectifying the obliquity may oftentimes be rendered unnecessary by the use of these means; yet, if required on account of the persistency of the abnormal conditions, it should not be postponed till the supervention of the more serious lesions.

A small amount of astigmatism gives rise to little visual disturbance; many of those before me would doubtless observe a difference in the clearness of their perception of horizontal or vertical lines; but in its high degrees, the confusion of images is often sufficient to disable its subject from study or reading. It can be relieved only by carefully fitted cylindrical glasses, which refract rays passing through their plane of curvature, while those passing through the plane of their axis are unaffected.

Not to recount all the anomalies which may cause fatigue of vision, I pass to the consideration of another important and most numerous class of cases, known as myopia or shortsightedness.

In near-sighted eyes, the globe is more or less elongated, principally at the expense of its posterior half. Its refractive power is thus in excess. Parallel rays are brought to a focus before reaching the back of the eye, and, crossing each other, form circles of dispersion upon the retina. Images of distant objects are therefore ill defined. But this high refractive power enables such eyes to form, with little effort, very clear images of minute near objects,—to read with less light than is required for distinct vision by normal eyes,—and to dispense with glasses for reading at and after the age when others must assume them, (though it is not true, as is commonly supposed, that near-sightedness diminishes with age, so far as distant objects are concerned, except to a very slight extent.) The impression therefore prevails that near-sighted eyes are stronger than others, and they are accordingly allowed to indulge themselves in the most trying occupations, in which myopic persons seem to take a peculiar pleasure,—reading by twilight or moonlight, writing a very small hand, doing elaborate needlework, etc. No mistake could be more serious. It is true, a very slight myopia may almost be regarded as an advantage, as giving a microscopic perfection to minute vision; but in its high degrees, it is a morbid condition, tending to great diminution or even loss of sight. Hyperopic eyes, as I have shown, are liable to sufficiently grave disabilities; but these have their limit; whereas myopia often involves far graver consequences. The short-sighted child, even if unable to see exercises upon the blackboard across the school-room without strained efforts, makes no complaint of any amount of minute work, if permitted to bring his eyes near his book or slate. Everything seems to be working smoothly with his visual apparatus while thus engaged; yet he is even then sowing the seed which is in many instances to bear bitter fruits of disappointment.

Myopia, as also hyperopia, is often inherited; and this congenital tendency may remain nearly dormant or even be gradually lessened; or it may be developed by improper management till it becomes a serious infirmity as regards the individual, and is transmitted, in a heightened degree, to his offspring.

It is during the years of study, say from ten to twenty years of age, that this progressive disposition is most marked. Before this time, the child pays little attention to small objects; and after this period, the tissues of the eye become firmer, and less subject to morbid change, provided this has not already begun.

It is therefore to teachers that we are to look to prevent the steady increase of disqualification and misfortune among those who are fitted, by intellectual culture, for the highest usefulness to society. The morbid changes I shall describe must be averted, not remedied; as, when once fully established, they are beyond the resources of professional skill.

The elongation of the axis of the globe, already mentioned as characteristic of myopia, comparatively seldom shows itself conspicuously in the front of the eye. The alteration in shape occurs mostly in the posterior half of the eyeball, where the tunics become distended and thinned. The layer of perceptive nerve tissue, the retina, follows, for a time, the change in the outer membranes, and, being thus spread over a larger surface, has less defining power in a given space than in a normal eye. But, besides this general giving way of the tissues, there is a special tendency to yield at and about the spot where the optic nerve enters the globe and expands to form the retina. This change, termed in professional parlance posterior staphyloma, which can be perfectly well seen with the ophthalmoscope, involves in a much higher degree the integrity of the nervous tissue, and its perceptive ability becomes lessened to an extent commensurate with the size of the staphyloma; though it may yet perhaps retain the power of conducting to the brain impressions received upon other portions of the retinal surface. Every degree of yielding renders the parts less able to resist a further change, and the bulging backwards is likely to increase, till at length, all the portions nearest the axis of vision having become involved, the sight is scarcely sufficient to allow of recognition of objects, with the aid of the strongest glasses. Even here, the morbid processes are not stayed; but the slightest imprudence in stooping or lifting, or in attempts to use the eyes, or any congestion of the globe, may at once cause effusion of fluid between the choroid and retina, forcing the latter from its normal position and suddenly extinguishing its powers. Blindness may and often does thus supervene in a single day.

Before the invention of the ophthalmoscope, but a very few years since, the pathology of this affection was far from being understood. It was regarded as an infirmity depriving its subject of many pleasures of vision, but no one looked upon it as an enemy within the camp waiting to accomplish a swift destruction. Near-sighted persons became blind, it is true; but the relation of cause and effect was never suspected: and as neither the patient nor the doctor saw anything, the loss of sight in the former was ascribed to amaurosis or paralysis of the optic nerve. Now, however, that we are able to discover these structural alterations, the full train of causes and consequences can be explained and demonstrated.

It is proper to give a brief exposition of the mode in which these changes are brought about, that we may learn how they may be prevented.

So long as a person having hereditary myopic tendencies keeps his head erect, and employs his eyes in looking at large objects only, the accommodative function is not brought into play, and, if he is only moderately short-sighted, he sees without effort and there is little congestion of the ocular circulation. If myopic to such a degree that his unassisted eye does not see objects at moderate distances, he may still obtain easy and distinct vision by the aid of concave glasses.

But if he strain his eyes by endeavoring to see, without glasses, objects beyond his range, as for instance figures on a too distant blackboard; or if he keep his head bent forward and his eyes continously fixed on small objects, congestion of the internal vessels is liable to ensue, and the eyes become predisposed to morbid changes. Furthermore, the increased posterior development of the eyeball, and the ovoid form it has assumed, make the attachment of its muscles relatively disadvantageous and the movements of rotation in the orbit less free. Accommodation for small objects is therefore effected with difficulty, and at the expense of considerable lateral pressure by the muscles upon the globe, which of course tends to aggravate the giving way of its thinned posterior portions.

As these processes go on, with their mutual action and reaction, accommodation grows more and more difficult, the internal recti muscles at last become insufficient to bring the deformed eyeballs to such a convergence as is requisite for binocular vision of near objects, and one eye gives up the effort to see and turns towards the temple, giving rise to divergent strabismus.

These phenomena form a sequence perfectly capable of explanation as to their mutual dependence. I do not mean to assert, however, that every near-sighted eye is imminently liable to all these dangers. In so doing, I should be refuted by the experience of many of those before me. Numbers of persons whose vision is excellent have even a high amount of myopia, perhaps continuing without change for years; but many of these instances are cases of acquired short sight, where the congenital tendency existed in only a low degree, and would never have been developed but for the devotion of the individual to studious pursuits. In such a case, the myopia having originated, in a great measure, at or near adult age, after the ocular structures had acquired firmness, resistance has been successfully opposed to the processes of degeneration, and they have not reached their maximum. But had the same person begun life with a considerable inherited myopia, a similar course of study might probably have induced progressive changes, which previous to adult age would have reached a degree precluding all hope of arrest at any point short of the gravest lesions.

Should the child of such a person exhibit obvious myopic symptoms, the parent must not presume too much upon his own immunity, but should take early precautions for his son's welfare.

The more extreme changes I have described are only rarely completed during school life. The mischief then begun reaches its full development in later years. The disease, for thus must myopia be regarded, is insidious in its approaches and in its advance, and therefore the more dangerous. Accustomed to imperfect perception of everything which is beyond a short distance from him, the myope is scarcely conscious that his sight grows gradually more and more imperfect; though he is perhaps aware that he is obliged to bring small objects nearer in order to see them distinctly. Thus he goes on, almost unwarned of danger, his eyes with eager diligence building the funeral pile of his hopes.

It is seldom before thirty, oftener not until fifty years of age or later, that the more fatal symptoms declare themselves, and vision is almost or entirely lost. But these sad cases are so frequent and so hopeless, and the lesser degrees of disability are so common, that the importance of early preventive measures cannot be too strongly urged. As I have said, remedies can do almost nothing to arrest this progressive deterioration. It is only by calling the attention of parents and teachers to the danger that it may be warded off and prevented from steadily increasing the number of its victims.

As before remarked, the teacher must not wait for complaint from his pupils. Except as regards the blackboard or other distant objects, no difficulty in using the eyes will be spoken of. If the teacher happens to be a high pressure engine, the visual machinery of his myopic pupil will apparently smoothly respond to all the impetus he may desire to give. The break-down will occur only at a future time; but it will none the less be the result of former misuse, and the consequence of the want of knowledge and foresight on the part of those intrusted with the control of the most delicate of all the vital mechanisms.

But the evil day is not always entirely thus put far off in the future. I may perhaps be pardoned for citing a case in illustration. Ten days ago, a girl of less than eleven years of age, was brought to me by her mother, who had been obliged to take her from school because she could not learn her lessons on account of pain in the eyes. I found a very high degree of myopia, and even with the strongest glasses her visual power was only of one-half the normal acuteness. The ophthalmoscopic and other examinations showed much retrocession of the whole retina and large posterior staphyloma. I said the child might go on carefully with some studies, but must lay others wholly aside. To this, the mother replied, "I have seen the head-master, who tells me she cannot go to school unless she keeps up with her class." This for her would be quite impossible, as well as most dangerous. She therefore cannot attend any public schools; her mother has no other resource, having small means and no culture; the child's education must therefore stop where it is. The history of the case made it evident that this was an instance of rapidly progressive myopia, induced by endeavors to maintain her standing as a very bright child high up in the grammar school.

Progressive myopic changes being unlikely to take place at mature age, except where they had already reached a considerable development during childhood and youth, it is of the first importance to avoid during those periods every cause which might initiate extreme morbid tendencies. The future of a myopic child ought to be made very early a matter for serious consideration, and he should not be allowed to select, as he will be strongly disposed to do, occupations requiring close and continuous application, with the head inclined forward, as in writing, engraving, sewing, etc.; but he should be trained for such pursuits as call for only general use of the eyes. This may often disappoint the fond wishes of his parents; though could they but have a glimpse of the hopeless future their ambition would prepare for him, they would think no sacrifice of profession or business too great if he might thus be saved from the impending evil.

During the years of study, then, the myopic pupil should not only not be required, but should not be permitted, to follow the usual routine. As far as possible, he should be excused from attempting to learn minute details, and from close and continuous work with lexicons or in mathematics. Written exercises, often requiring of the eye double duty, first to learn the lesson, afterwards to write it, should by all means be dispensed with, except in composition. Map or other drawing requiring exactness, should be interdicted. The child should be taught to make his ears as well as his eyes useful servants to his memory, by giving close attention to oral instruction. Perfection in technical minutiæ, important to class rank under a formal system, but often of slight practical value, should be made of little account, and the pupil should be advised rather to rest satisfied with a knowledge of important general facts and principles. He should pursue, for the most part, only such studies as are likely to be of most consequence to him; or, if desirous of further acquirement, he should study less assiduously than others, with frequent interruptions, and without caring whether his position is at one end or the other of his class. When he can, he should hold his book up before his eyes, keeping his head erect; and where this is impossilbe, as in work on the slate or in writing, he should not keep the head bent forward too long at a time. Should he study languages, he should avoid continuous work; often varying his occupation by giving his attention to something else, and should make no attempt at rapid progress.

Where concave glasses are needed for looking at a blackboard or at a distance, they should not, as a general rule, be worn while studying. If required for this use also, to avoid stooping over the desk, a weaker pair than is needed for distant vision will usually best answer the purpose.

It is important, also, that the eyes should not be exposed to dazzling light, as is unfortunately the case in many school-rooms, where only the teacher is favorably placed in this respect.

Doubtless this indulgent consideration for the optical defects of pupils may have its inconveniences in a crowded school; but I am sure teachers will agree with me that the object of instruction is not to compress a certain quantum of information into every individual, but to render each capable, as far as may be, of using what he does know to the best advantage. Therefore, as the eyes are the most important of the instrumentalities by which we gain knowledge and can make it afterwards available, their safety demands our utmost care. Their soundness as the working organs in school, and as the chief helpers of the cultivated man, may depend upon the thoughtful consideration we give to their infirmities in childhood, before these assume the dimensions of serious disease.

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